MICROBICIDAL SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] This invention relates to microbicidal systems and their use to purify fluids.

State of the Technology

[0002] Pathogenic contaminants pose an ongoing challenge for public health, particularly in water and air. The Legionnaires' disease organism illustrates the problem. *Legionella pneumophila* serogroup 1 (Lp1) is a bacterium found naturally in freshwater lakes and streams. When it finds its way into water systems in buildings, it can proliferate in showerheads and sink faucets, cooling towers, poorly managed hot tubs, decorative fountains, hot water heaters and tanks, and large plumbing systems. Lp1 can survive at temperatures up to ~145° F. (60° C.). If the water is dispersed in fine droplets in mists or showers, it can be inhaled, just as it can be inhaled from contaminated air. Lp1 is pernicious in persons with weakened lungs, such as: current and ex-smokers; cancer and lung disease patients; patients 50 years of age or older; and patients with diabetes, kidney disease, or liver disease. In fact, Lp1 infects far more effectively by transfer in contaminated water than from person to person. Lp1 causes Legionnaire's disease or sometimes flu-like Pontiac fever; 10,000 cases of Legionnaire's disease are diagnosed annually in the U.S. but it is infrequently tested for, thus badly underdiagnosed. One tenth of known Legionnaire's patients die from the condition. Other airborne diseases are better known but similarly problematic, for pathogens ranging from flu and cold viruses to coronavirus.

[0003] The obvious solution is to disinfect the media by which these pathogens infect humans. However, both water and air are commodities, meaning that they are inexpensive and used in large quantities. Consequently, their purification must be fast, reliable, effective, convenient, and cost-competitive with the existing technologies. For instance, to find wide use the technology must be essentially fail-proof for long periods under a wide variety of operating conditions. And the maintenance, replacement and downtime must be kept to a minimum.

[0004] Applications for water purification range from potable drinking water to fermentation media and separation of components in biological fluids. The latter two are especially sensitive to microbial contaminants. Applications for air purification include (re)circulated air in homes, offices, hospitals, clean rooms, air- and spacecraft. HEPA filters are popular to remove microbial particulates such as dust, mold, and allergens from air.

[0005] Existing water- and air purification methods are diverse, including distillation, reverse osmosis, ion-exchange, chemical adsorption, coagulation and filtering or retention (physical occlusion of particulates). Chemical methods include the use of reagents to oxidize, flocculate or precipitate impurities. The range of particle size exclusion depends on the size of pores or interstitial spaces in membranes and granular materials, respectively. Other methods use purification materials that react chemically with contaminants. Generally, complete purification requires a plurality of complementary techniques, so it is common to employ several devices in series, each with a different function. Examples include mixed resins to remove negatively and positively charged species as well as charge-neutral species.

[0006] However, processing and apparatus costs limit the scope of economically viable applications. And the thriftiest techniques have been insufficiently effective against microbial contaminants such as bacteria and viruses. Membranes to remove cell-sized particulates are still somewhat pricey, yet the alternative is to use potent chemicals such as bleach, chlorine, ozone, and the like.

[0007] The Environmental Protection Agency (EPA) regulates water sanitation devices. It requires that purification leave essentially no chemical trace in water, and that the microbial content be virtually eliminated. This includes at least a 6-log reduction (99.9999%) in common coliforms, represented by the bacteria *E. coli* and *Klebsiella terrigena*, for samples in which they are present initially at 1×10^7 (cells)/100 mL. For claimed removal of common viruses, as represented by process-resistant poliovirus 1 (LSc) and rotavirus (Wa or SA-11), the EPA requires a 4-log reduction, 99.99% of cells, from an 1×10^7 (cells)/L influent. Another challenge is protozoa, which commonly exist in cysts and cause diarrhea, as represented by *Giardia muris* or *Giardia lamblia*. Protozoa are widespread, difficult to treat medically, and resist chemical disinfection. The EPA's minimum standard there is a 3-log reduction, 99.9% of cysts removed, from 1×10^6 (cells)/L or 1×10^7 (cells)/L influent. The EPA has allowed the use of inanimate particles of comparable size as a stand-in for disease cells when testing devices.

[0008] The EPA has not established comparable standards for Lp1 control, but estimates that current municipal water purification provides a 3-log (99.9%) reduction in Legionella bacteria before it enters buildings. Seemingly Lp1 colonizes and proliferates there afterward.

[0009] Certain work on water purification has focused on chlorhexidine and its derivatives to eliminate microbes. Examples follow.

[0010] U.S. Pat. Pub. No. 2007-0218522 (McCoy) discloses use of chlorhexidine to kill *Legionella* and other heterotrophic aerobic bacteria collected from plumbing and water supplies, for the purpose of counting them.

[0011] U.S. Pat. Pub. No. 2008-0272062 (Gooch et al, Nov. 6, 2008) discloses a pass-through fluid treatment device within which is secured a broad-spectrum antimicrobial material such as a biguanide hydrate such as chlorhexidine hydrate.

[0012] U.S. Pat. Pub. No. 2008-0306301 (Gooch et al., Dec. 11, 2008) discloses a composition for treating water, air and other fluids. It includes a biguanide dihydrate compound, such as a hydrate of chlorhexidine, with broad spectrum antimicrobial activity.

[0013] U.S. Pat. Pub. No. 2009-0191250 (Gooch et al., Jul. 30, 2009) discloses composite materials with broad spectrum antimicrobial properties for fluid treatment. The materials may include combinations of activated carbon and with particles of chlorhexidine hydrate, useful in fixed particle bed water treatment devices and methods.

[0014] U.S. Pat. Pub. No. 2010-0125105 (Gooch, May 20, 2010) discloses fibers and particulates comprising a thermoplastic polyolefin into which is blended 1-25 weight % antimicrobial bisguanide compound such as chlorhexidine.